AD-A092 815 PRINCETON UNIV NJ DEPT OF ELECTRICAL ENGINEERING AND--ETC F/G 9/3
NOVEL DIGITAL SIGNAL PROCESSING AND DETECTION TECHNIQUES.(U)
SEP 80 B LIU AFOSR-76-3083

UNCLASSIFIED AFOSR-TR-80-1181 NL

END
DATE FILMED
1 81
DTIC

INTERIM SCIENTIFIC REPORT

Grant [redacted] AFOSR-76-3083

NOVEL DIGITAL SIGNAL PROCESSING AND DETECTION TECHNIQUES

(1 August 1979 - 31 July 1980)

This report summarizes the research conducted under Grant [redacted] AFOSR-76-3083 during the period 1 August 1979 to 31 July 1980. In the discussion below, the numbers in the bracket [ ] refer to the items on the attached list of papers that have been either published or accepted for publication.

Errors due to arithmetic roundoff and coefficient quantization can be very large for second order recursive digital filters with poles near the unit circle. The read-only-memory/accumulator (ROM/ACC) implementation of two special filter structure are analyzed [2,3]. Expressions for the mean squared error and bounds on the zero-input limit cycles are derived for these structures and shown to be small. These new structures can offer significant hardware and speed advantages. Bounds on limit cycles in second order filters that uses error specturm shaping have been derived and shown to be considerably smaller than a similar bound for the straightforward implementation [9]. Be allowing one or two multiplications in the error specturm shaping implementation of filters with poles near the unit circle, it is shown that the bounds for the limit cycles can not exceed two bits [10].

The sequential dead-zone limiter detector originally proposed by Shin and Kassam may be treated as a generalized ruin problem that includes ties, and the sequential four level sign detector may be treated as another generalization of the classical ruin problem[1]. These two detectors are analyzed using this approach and their performances compared to that of the more familiar sequential sign detector in terms of relative efficiency and asymptotic relative efficiency. The Neyman-Pearson optimal detector and a likelihood ratio detector can sometimes be designed by first transforming the input data and their statistical characteristics into a multinomial vector and a set of multinomial parameters[8]. These detectors can be simple, flexible and their performance can be quite good.

The need often arises in practice for a correlated non-Gaussian random sequence for purposes of testing and simulation. A scheme consisting of a white noise Gaussian input to a digital filter followed by a zero-memory nonlinearity is proposed and analyzed [4]. The nonlinearity is chosen so that the desired distribution is exactly realized and the digital filter is designed so that the desired autocorrelation function is approximated. A number of theoretical questions in connect on with this scheme are answered.

The prime factor FFT makes use of some recent computational complexity results by Winograd to compute the DFT with a fewer number of multiplications than required by the FFT. An expression for the MSE due to roundoff error when floating point arithmetic is used is derived and a simple bound on the MSE is obtained [5].

Presently, programmable CCD filters are implemented through involved additional complexity at each filter tap. A delta modulation like sampled analog filter structure for realizing low-pass filter is developed [6,7]. By employing decimation and interpolation, the filter uses only coefficients 0, +1, and -1 and can be fabricated as a programmable CCD filter.

Other works during theis period also include a further refinement of narrowband specturm analysis by direct decimation and the use of recursive filters for decimation and interpolation [11,12].

Submitted by:

Bede Liu

Bede Liu
Department of Electrical
Engineering and Computer Science
Princeton University
Princeton, New Jersey 08544

September 1980

PUBLICATIONS

(August 1979 to July 1980)

Papers Published

1. "Generalizations of the Sequential Sign Detector", C.C. Lee and J.B. Thomas, Proc. Seventeenth Annual Allerton Conf. on Comm. Control, and Computing, October 1979,pp. 848-857.

2. "ROC/ACC Realization of Digital Filters for Poles Near the Unit Circle", D.C. Munson Jr. and B. Liu, IEEE Trans. on Circuits & Systems, Vol. CAS-27, No. 2, February 1980, pp. 147-151.

3. "Low-Noise Realizations for Narrow-Band Recursive Digital Filters", D.C. Munson Jr. and B. Liu, IEEE Trans. on Acoustics, Speech, and Signal Processing, Vol. ASSP-28, No. 1, February 1980, pp. 41-54.

4. "On Computer Generation of Random Sequences", D.C. Munson and B. Liu, Proc. Fourteenth Annual Conf. on Info. Sciences & Systems, Princeton, NJ, March 1980.

5. "Floating Point Error Bound in the Prime Factor FFT", D.C. Munson Jr. and B. Liu, IEEE Int. Conf. on Acoustics, Speech and Signal Processing, April 1980, pp. 69-72.

6. "Programmable CTD Filtering Using Coefficients 0,+1, and -1", M.R. Bateman and B. Liu, IEEE Inst. Sym, Circuits and Systems, April 1980, pp. 134-137.

7. "An Approach to Programmable CTD Filters Using Coefficients 0,+1, and -1", M.R. Batemand and B. Liu, IEEE Trans. on Circuits and Systems, Vol. CAS-27, No. 6, June 1980, pp. 451-456.

Papers Accepted for Publication

8. "Signal Detection Based on Discrete Data," C.C. Lee and J.B. Thomas, Eighteenth Annual Allerton Conf. on Comm., Control and Computing, October 1980.

9. "Narrowband Recursive Filters with Error Spectrum Shaping," D.C. Munson Jr. and B. Liu, IEEE Trans. on Circuits and Systems.

Papers Submitted for Publication

10. "Limit Cycle Bounds for Digital Filters with Error Spectrum Shaping," M.R. Bateman and B. Liu, submitted to IEEE Trans. on Acoustics,Speech, and Signal Processing.

11. "A Direct Decimation Algorithm for Narrow-Band Spectrum Calculation, M. Quirk and B. Liu, IEEE Tran. on Acoustics, Speech, and Signal Process.

12. "Efficient Sampling Rate Alteration Using Recursive (IIR) Digital Filters," R. Ansari and B. Liu, IEEE Trans. on Acoustics, Speech, and Signal Processing.

AFOSR-TR- 80 - 1181

INTERIM SCIENTIFIC REPORT

Grant [redacted]AFOSR-76-3083

NOVEL DIGITAL SIGNAL PROCESSING AND DETECTION TECHNIQUES

(1 August 1979 - 31 July 1980)

This report summarizes the research conducted under Grant [redacted]AFOSR-76-3083 during the period 1 August 1979 to 31 July 1980. In the discussion below, the numbers in the bracket [ ] refer to the items on the attached list of papers that have been either published or accepted for publication.

Errors due to arithmetic roundoff and coefficient quantization can be very large for second order recursive digital filters with poles near the unit circle. The read-only-memory/accumulator (ROM/ACC) implementation of two special filter structure are analyzed [2,3] . Expressions for the mean squared error and bounds on the zero-input limit cycles are derived for these structures and shown to be small. These new structures can offer significant hardware and speed advantages. Bounds on limit cycles in second order filters that uses error specturm shaping have been derived and shown to be considerably smaller than a similar bound for the straightforward implementation [9]. Be allowing one or two multiplications in the error specturm shaping implementation of filters with poles near the unit circle, it is shown that the bounds for the limit cycles can not exceed two bits [10].

The sequential dead-zone limiter detector originally proposed by Shin and Kassam may be treated as a generalized ruin problem that includes ties, and the sequential four level sign detector may be treated as another generalization of the classical ruin problem[1]. These two detectors are analyzed using this approach and their performances compared to that of the more familiar sequential sign detector in terms of relative efficiency and asymptotic relative efficiency. The Neyman-Pearson optimal detector and a likelihood ratio detector can sometimes be designed by first transforming the input data and their statistical characteristics into a multinomial vector and a set of multinomial parameters[8]. These detectors can be simple, flexible and their performance can be quite good.

The need often arises in practice for a correlated non-Gaussian random sequence for purposes of testing and simulation. A scheme consisting of a white noise Gaussian input to a digital filter followed by a zero-memory nonlinearity is proposed and analyzed [4]. The nonlinearity is chosen so that the desired distribution is exactly realized and the digital filter is designed so that the desired autocorrelation function is approximated. A number of theoretical questions in connect on with this scheme are answered.

The prime factor FFT makes use of some recent computational complexity results by Winograd to compute the DFT with a fewer number of multiplications than required by the FFT. An expression for the MSE due to roundoff error when floating point arithmetic is used is derived and a simple bound on the MSE is obtained [5].

Presently, programmable CCD filters are implemented through involved additional complexity at each filter tap. A delta modulation like sampled analog filter structure for realizing low-pass filter is developed [6,7]. By employing decimation and interpolation, the filter uses only coefficients 0, +1, and -1 and can be fabricated as a programmable CCD filter.

Other works during theis period also include a further refinement of narrowband specturm analysis by direct decimation and the use of recursive filters for decimation and interpolation [11,12].

Submitted by:

Bede Liu

Bede Liu
Department of Electrical
Engineering and Computer Science
Princeton University
Princeton, New Jersey 08544

September 1980

PUBLICATIONS

(August 1979 to July 1980)

Papers Published

1. "Generalizations of the Sequential Sign Detector", C.C. Lee and J.B. Thomas, Proc. Seventeenth Annual Allerton Conf. on Comm. Control, and Computing, October 1979,pp. 848-857.

2. "ROC/ACC Realization of Digital Filters for Poles Near the Unit Circle", D.C. Munson Jr. and B. Liu, IEEE Trans. on Circuits & Systems, Vol. CAS-27, No. 2, February 1980, pp. 147-151.

3. "Low-Noise Realizations for Narrow-Band Recursive Digital Filters", D.C. Munson Jr. and B. Liu, IEEE Trans. on Acoustics, Speech, and Signal Processing, Vol. ASSP-28, No. 1, February 1980, pp. 41-54.

4. "On Computer Generation of Random Sequences", D.C. Munson and B. Liu, Proc. Fourteenth Annual Conf. on Info. Sciences & Systems, Princeton, NJ, March 1980.

5. "Floating Point Error Bound in the Prime Factor FFT", D.C. Munson Jr. and B. Liu, IEEE Int. Conf. on Acoustics, Speech and Signal Processing, April 1980, pp. 69-72.

6. "Programmable CTD Filtering Using Coefficients 0,+1, and -1", M.R. Bateman and B. Liu, IEEE Inst. Sym, Circuits and Systems, April 1980, pp. 134-137.

7. "An Approach to Programmable CTD Filters Using Coefficients 0,+1, and -1", M.R. Batemand and B. Liu, IEEE Trans. on Circuits and Systems, Vol. CAS-27, No. 6, June 1980, pp. 451-456.

Papers Accepted for Publication

8. "Signal Detection Based on Discrete Data," C.C. Lee and J.B. Thomas, Eighteenth Annual Allerton Conf. on Comm., Control and Computing, October 1980.

9. "Narrowband Recursive Filters with Error Spectrum Shaping," D.C. Munson Jr. and B. Liu, IEEE Trans. on Circuits and Systems.

Papers Submitted for Publication

10. "Limit Cycle Bounds for Digital Filters with Error Spectrum Shaping," M.R. Bateman and B. Liu, submitted to IEEE Trans. on Acoustics,Speech, and Signal Processing.

11. "A Direct Decimation Algorithm for Narrow-Band Spectrum Calculation, M. Quirk and B. Liu, IEEE Tran. on Acoustics, Speech, and Signal Process.

12. "Efficient Sampling Rate Alteration Using Recursive (IIR) Digital Filters," R. Ansari and B. Liu, IEEE Trans. on Acoustics, Speech, and Signal Processing.

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER (19) AFOSR-TR-80-1181	2. GOVT ACCESSION NO. AD-A092 825
4. TITLE (and Subtitle) (6) NOVEL DIGITAL SIGNAL PROCESSING AND DETECTION TECHNIQUES.	5. TYPE OF REPORT & PERIOD COVERED Interim
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) (10) Bede / Liu (11) Sep 71 (15)	8. CONTRACT OR GRANT NUMBER(s) AFOSR-76-3083
9. PERFORMING ORGANIZATION NAME AND ADDRESS Dept. of Electircal Eng. & Computer Science Princeton University Princeton, New Jersey	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS (16) 61102F (17) 2304/A6
11. CONTROLLING OFFICE NAME AND ADDRESS Air Force Office of Scientific Research/NM Bolling AFB, Washington DC 20332	12. REPORT DATE July 1980 (12) 22
	13. NUMBER OF PAGES 3
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) (9) Interim scientific rept. 1 Aug 79-31 Jul 80.	15. SECURITY CLASS. (of this report) UNCLASSIFIED
	15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A number of results were obtained during the period 1 August 1979 to 30 July 1980. Studies were made of the implementation of narrowband digital filters with reduced roundoff error and limit cycle oscillations. Bounds on limit cycles of second order filters were derived for filters using error sepctrum shaping. The performance of two sequential signal detectors were analyzed. A schemee for the computer generation of random sequences with a specified first order distribution and a specified autocovariance function is proposed and analyzed. A delta modulation like sampled analog filter structure is

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED 409434

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

developed. The filter uses only coefficients 0,+1, and -1, and can be fabricated as a programmable CCD filter. Work has begun on a further refinement of narrowhead spectrum analysis by direct decimation and on the use of recursive filters for decimation and interpolation. ←